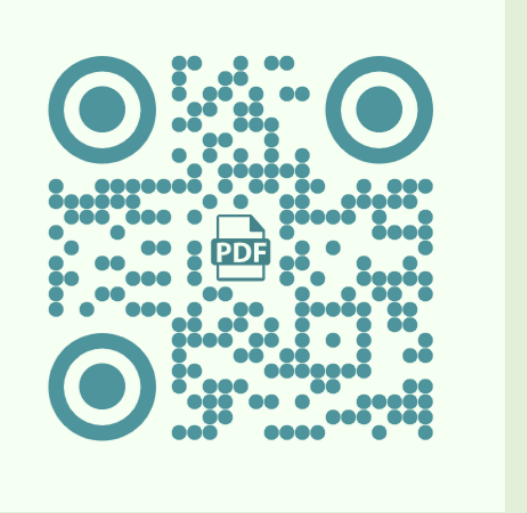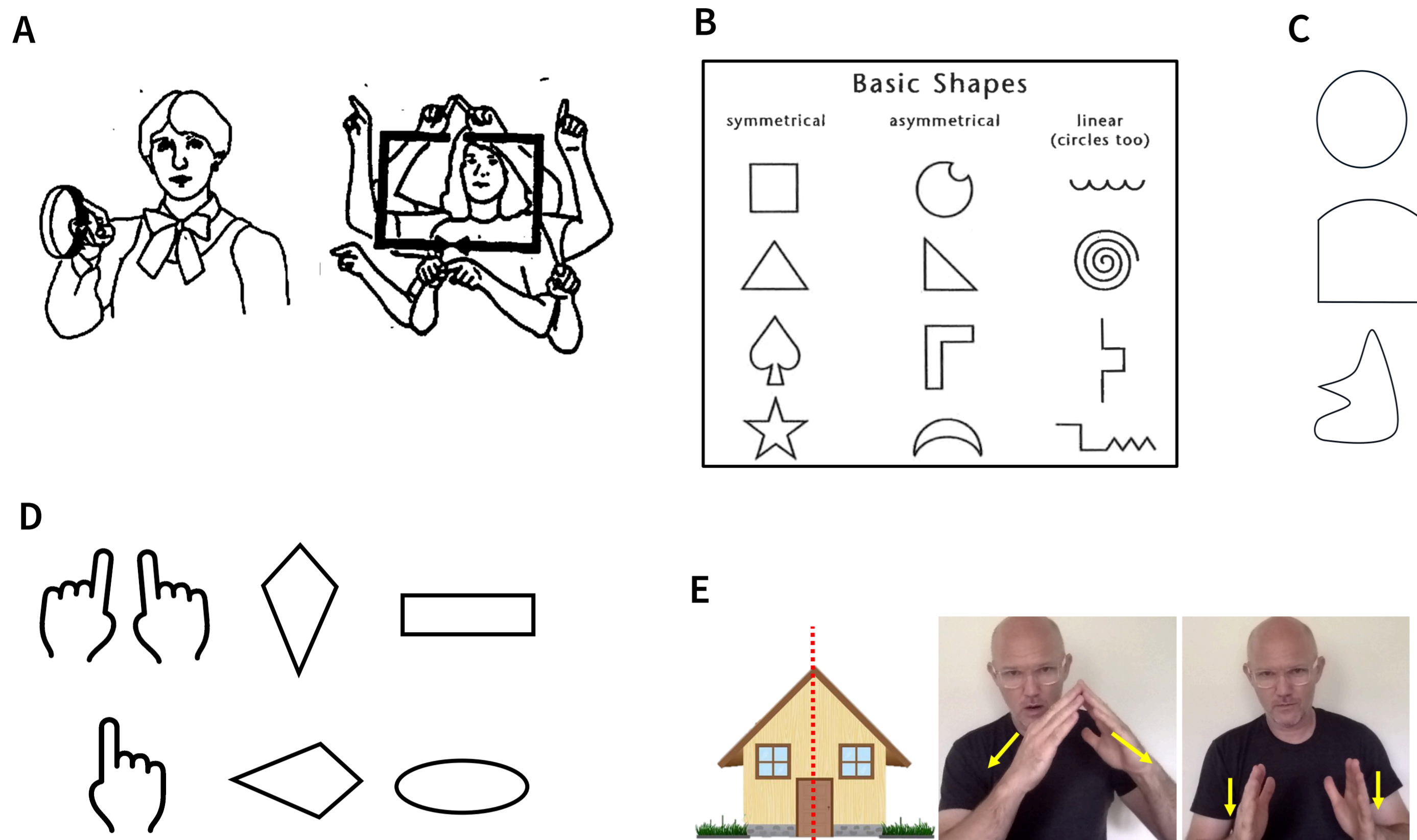# Handshape, Movement, and Geometry: Communicating shapes in sign languages

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A. In ASL and other SLs, signing a shape involves tracing it in the air. Some are traced with one moving hand ("Method 1"), and others with two ("Method 2")[1].

B. Students are taught to sign shapes via categories, such as those in this figure[2]. However, the criteria given are often contradictory and imprecise.

C. We assembled a set of both "canonical" and "novel" shapes to identify the relevant geometric principles, and recorded signers producing them.

D. The best predictors of Method choice (1 vs 2) were whether a shape had Y-axis symmetry and whether it had any curved edges.

E. We then analyzed ASL signs that are iconic of an entity's shape and found that the same predictors surfaced, as seen in the sign for HOUSE.

Signer Survey

17 deaf signers (ASL,12; LIBRAS, 1; LIS, 1; SL of the Netherlands (NGT), 2; Turkish SL, 1) were recorded conveying each of 49 shapes.

A logistic regression revealed **the strongest predictors of one-handed vs two-handed production were whether the shape has any curved edges (one hand) and whether the shape is symmetrical across the Y-axis (two hands)**.

Dictionary Survey

One online ASL dictionary[3] was analyzed, along with samplings across three others[4] to find entries with concrete sense whose movement draws the outline of (part of) the object. This yielded a set of 137 distinct signs. Signs fell into one of three categories:

+Ysym -Curve (HOUSE)
+Curve (ELEPHANT)
-Ysym -Curve (RHINO)

112/137 signs are consistent with the predictions of the shapes survey.

Box plots of the use of Method 2
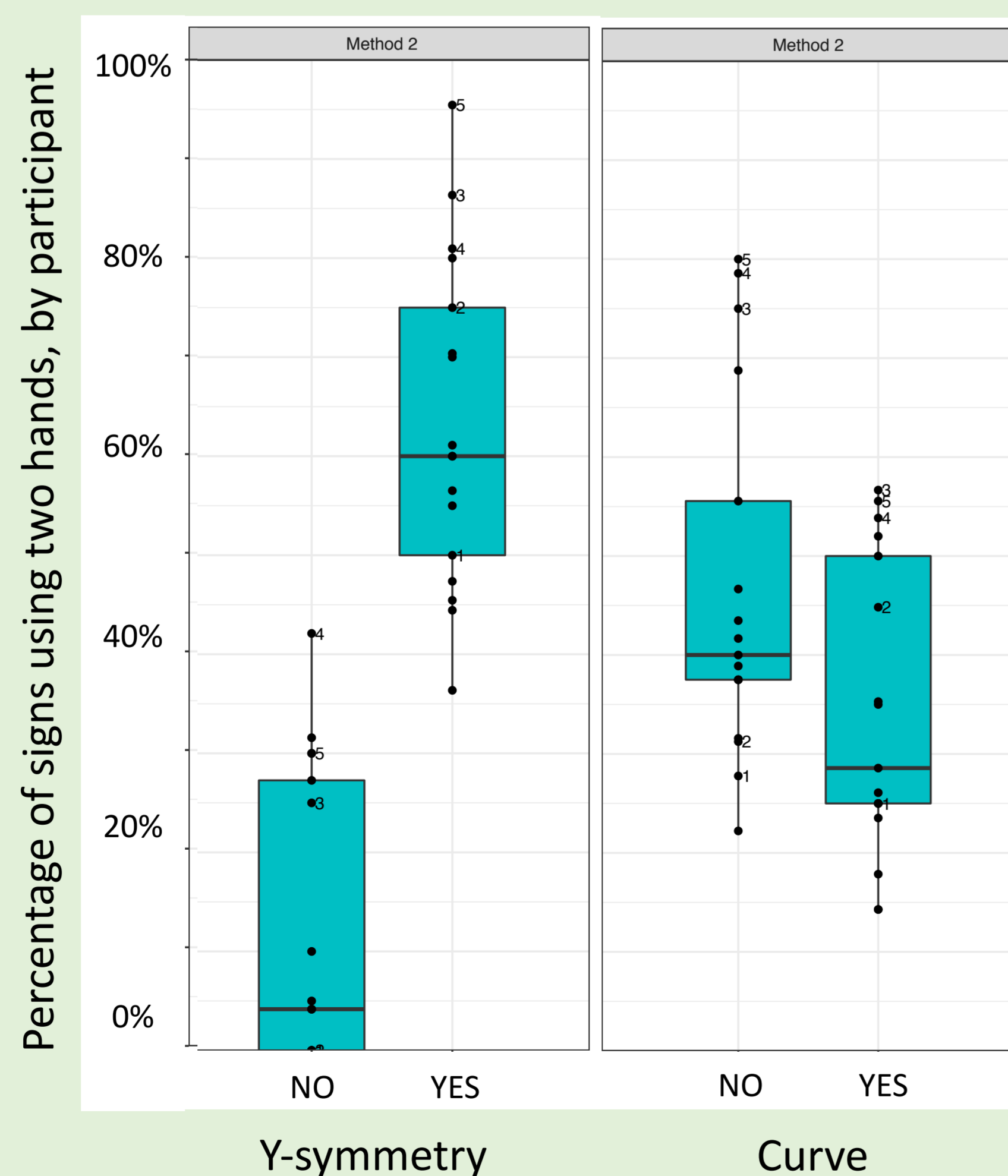
Lexical Drawing Principle: If the primary movement path* of a lexical item is iconic of an entity's shape, and if that path is +YSym and −Curve, the lexical item is more likely to involve two moving hands; otherwise it is more likely that only one hand will move.

*Primary movement is the result of shoulder and/or elbow articulation.

Discussion- Why bother with two hands?

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Costs	X biomechanical effort
	X coordination as a cognitive burden (see brain injury studies)[5]
	X coordinating movement of multiple muscles around multiple joints on different limbs
Expressive advantages in the lexicon:	✓ size relationships (GETTING-BIGGER)
	✓ action of one character on an object or another character (as in FLATTER)
	✓ reciprocal action (as in LOOK-AT-EACH-OTHER)
	✓ Signers are used to paying those costs
Expressive advantages in shapes	✓ Each method is a kind of over-specification
	✓ This redundancy enhances comprehensibility and resolves ambiguity[6]

What role does handshape play?

Handshape did not impact Method choice in the shapes survey **BUT** we might expect it to in the dictionary survey (handshape can convey more than just the outline).

Dictionary Survey 2
We analyzed 120 signs in an ASL online dictionary[3] whose movement draws the shape of the entity.

surface-drawing (Flat-B, B, claw, 5, C, O); used with thick entities (a noticeable third dimension)

edge-drawing (1, I, h, baby-C, 4, v, 1-I); used with flat entities ("two-dimensional")
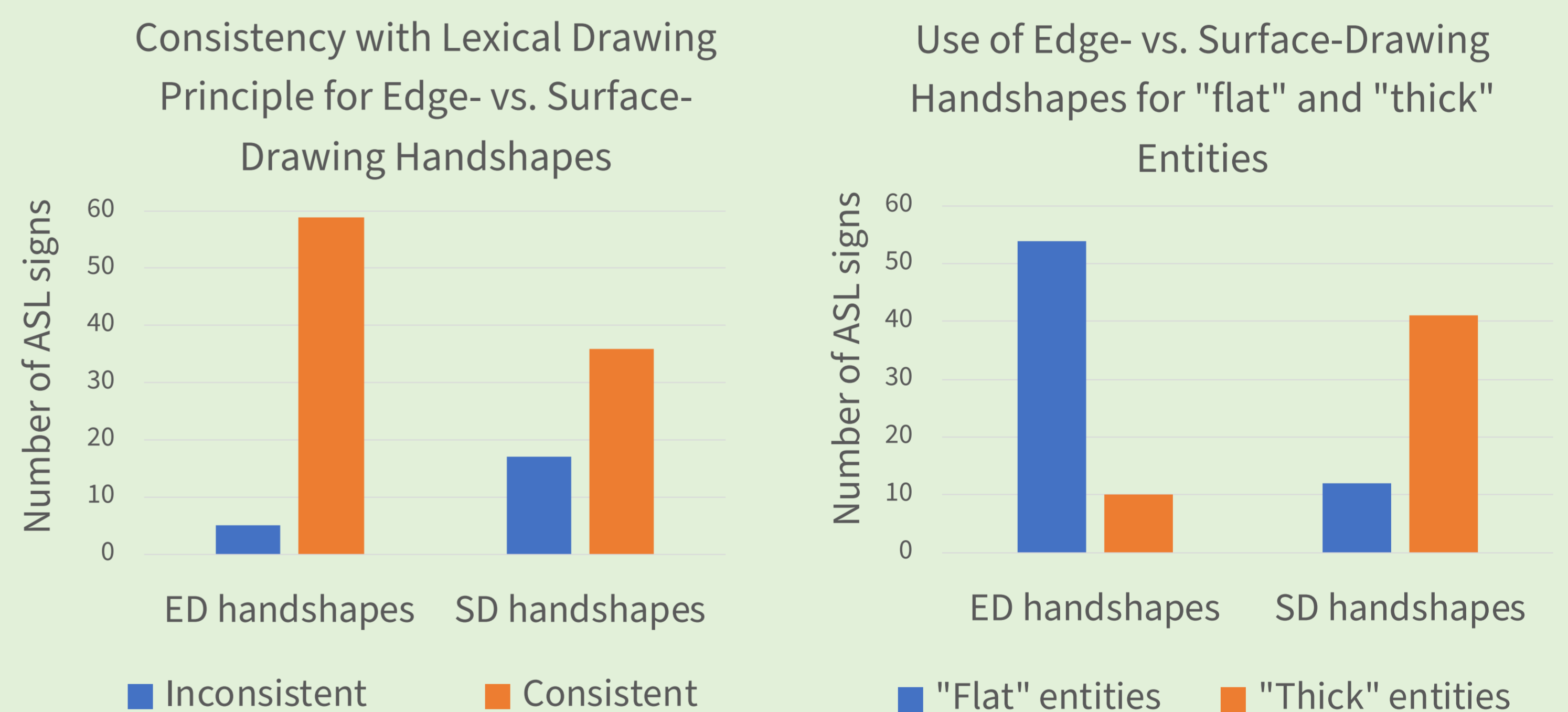
Dimension Principle: If path movement is iconic in that it draws (part of) the signified entity, then edge-drawing handshapes should be used for two-dimensional entities, whereas surface-drawing handshapes should be used for three-dimensional entities.

Lexical Drawing Principle holds more strongly with signs that use edge-drawing handshapes than with signs that use surface-drawing handshapes.

Highlights

- The way shapes are signed in ASL (and several other SLs) relies on **consistent geometric principles.**

- **Curved edges and Y-axis symmetry** are the strongest predictors of one vs. two-handed signing of shapes (respectively).

- For signs that are iconic of an entity's shape, the same predictors apply **(Lexical Drawing Principle)**.

- If path is iconic, edge-drawing handshapes should be used for 2-D entities, and surface-drawing handshapes should be used for 3-D entities **(Dimension Principle)**.

References
1. Figure taken from Costello, E. (1994). *American Sign Language Dictionary*. New York: Random House.
2. Figure taken from Smith, Lentz, & Mikos, 1998, p. 103, reprinted with permission of Dawn Sign Press
3. www.aslpro.com
4. www.handspeak.com, www.signingsavvy.com, and www.spreadthesign.com
5. de Oliveira, S. D. (2002). The neuronal basis of bimanual coordination: Recent neurophysiological evidence and functional models. Acta Psychologica, 110(2–3), 139–159.
6. Łubowicz, A. (2003). Contrast preservation in phonological mappings. University of Massachusets, Amherst dissertation, (February).